FM-OAP101/102/103 Series
Output Analog Pneumatic Function Modules

Introduction

Application Overview

The OAP Function Module assemblies are electric to pneumatic interface devices used to convert electronic signals from a controller into proportional pressure outputs for pneumatic field devices. These field devices are typically pneumatic valve or damper actuators, but the FM-OAP is not limited to these applications. Control of field devices utilizes an OAP102 (manual module) with either the OAP101 or the OAP103 (auto modules), which connect together and form a 2-slot Function Module Assembly.

Theory of Operation

There are three modules in the Output Analog Pneumatic Function Module (FM-OAP) series:

- The FM-OAP101, which accepts a digital signal, and is designed for use with the Digital Control Module (DCM) in a Network Control Panel (NCU/NEU).
- The FM-OAP103, which accepts a current signal, and is designed for use in a Function Module Kit (FMK) with an AHU (Air Handling Unit) or an LCP (Lab and Central Plant) controller.
- The FM-OAP102, which is required with either the OAP101 or the OAP103 Module. It allows manual control of the field device and provides a pressure supply port and an output port to the field device. It can be ordered and commissioned before the OAP101 or OAP103 is present to provide manual control during construction and maintenance.

See Figure 1 for a schematic diagram of how the OAP assemblies work.

To convert a control signal into a pneumatic signal, the FM-OAP101/102 assembly or the FM-OAP103/102 assembly performs the following steps:

1. The controller (usually a DCM or an AHU) sends a control signal to the OAP Auto Module (OAP101 or 103).
   - The OAP101 converts the digital signal into a current signal.
   - The OAP103 uses the current signal directly from the controller.
2. The current signal is converted by the transducer into a proportional pressure signal.
3. The proportional pressure signal then is sent to the OAP102 (Manual Module). The signal proceeds to the field device along one of two paths:
   - When the assembly is in Auto (A) mode, this pressure signal is transmitted to the field device.
   - When the assembly is in Manual (M) mode, this pressure signal is blocked and a manual signal based on the position of the output adjustment knob is sent to the field device.

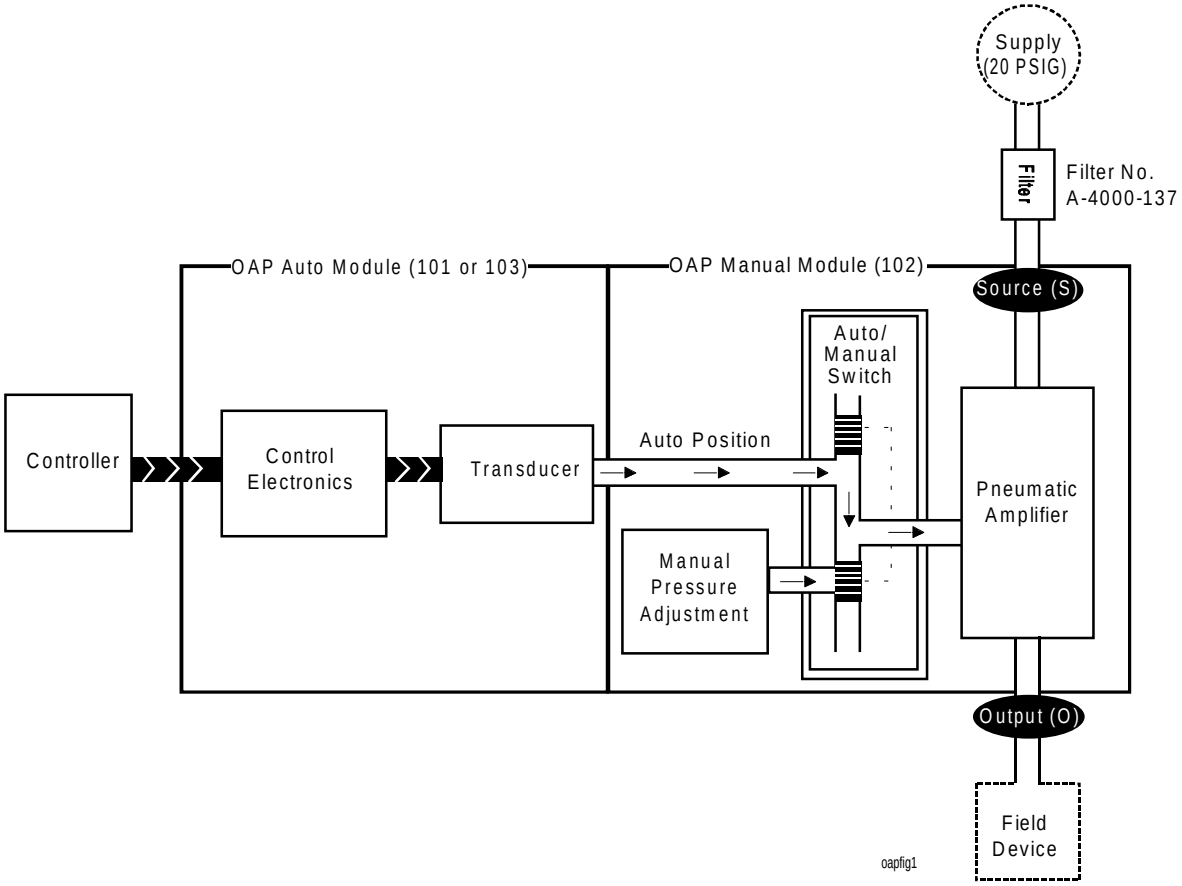

Figure 1: OAP Functional Diagram

Typical Applications

Figures 2a and 2b diagram typical applications of the OAP101/102 with a DCM and an OAP103/102 with an AHU. Tubing connections are similar for all applications; wiring connections are determined by controller type.

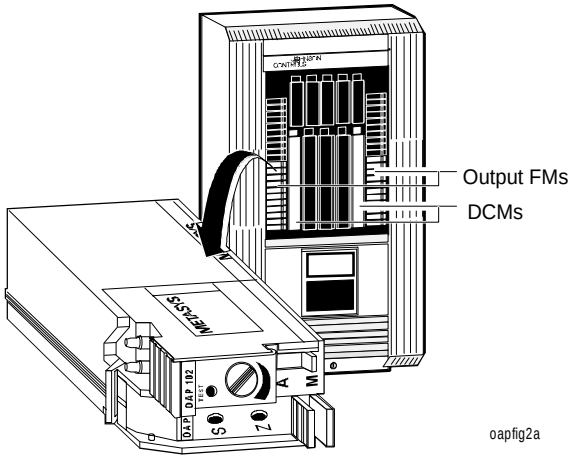

Figure 2a: A Typical FM-OAP101/102 Application with the DCM in an NCU/NEU

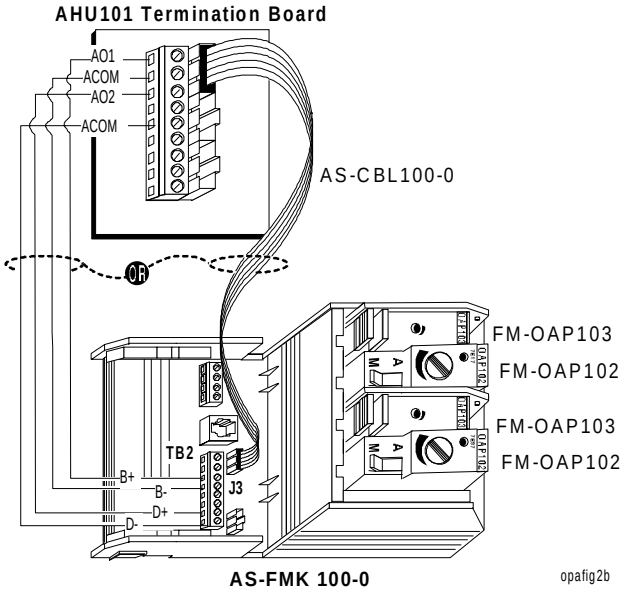

Figure 2b: Wiring Connections for a Typical FM-OAP103/102 Application in an FMK with an AHU Controller

Installation

Assumptions

- Controller is installed.
- Controller system terminology is familiar.
- The location and operation of power switches are known.
- Engineering drawings defining details for the installation are available.

Guidelines

- Connect pneumatic ports to air lines only. Do NOT connect ports to steam, gas or water lines.
- Provide clean, dry, instrument-quality air supply.
- Use the supply air filter supplied with the OAP102.
- When the spring range of the actuator is unknown, set the OAP span wider than the nominal spring range to accommodate spring shift.
- Observe the following specifications:

	FM-OAP101	**FM-OAP103**
Input	10 bit DCM signal, 0 to 100% of adjusted zero and span	0 to 20 mA Max. resistance = 375 ohms
Output	Min. flow = 400 SCIM at 3 to 15 PSIG (107 ml/s at 21 to 103 kPa)	Min. flow = 400 SCIM at 3 to 15 PSIG (107 ml/s at 21 to 103 kPa)

Note: All wiring should conform to the National Electric Code and local regulations.

Procedures

1. Separate the OAP102 module from the OAP101 or OAP103 module.
2. Refer to the engineering drawings, and identify the proper location for this function module assembly.

Note: The **OAP101/102** assembly requires an adjacent pair of slots and cannot use the number 2/3 or number 6/7 slot pairs in a base frame. The **OAP103** connector pins must be inserted into either slots A/B or slots C/D of the FMK.

3. Open the latch on the OAP101 or OAP103 by squeezing together the vertical blue latch tabs on the front of the module and swinging the latch open. See Figure 3.
4. Insert the OAP101 or OAP103 in the appropriate slot, as indicated by the engineering drawings.
5. Close latch to lock the function module into the slot.

6. Set the Auto/Manual switch on the corresponding OAP102 to Manual (M). See Figure 3.
7. Adjust the output of the OAP102 to minimum by turning the blue output adjustment knob counterclockwise until it stops turning. Do NOT force the knob beyond this point.
8. Connect the supply pressure line to the port marked “S” and the output line to the port marked “O” on the OAP102 as in Figure 3.
9. Insert the OAP102 Module into the OAP101 or OAP103.

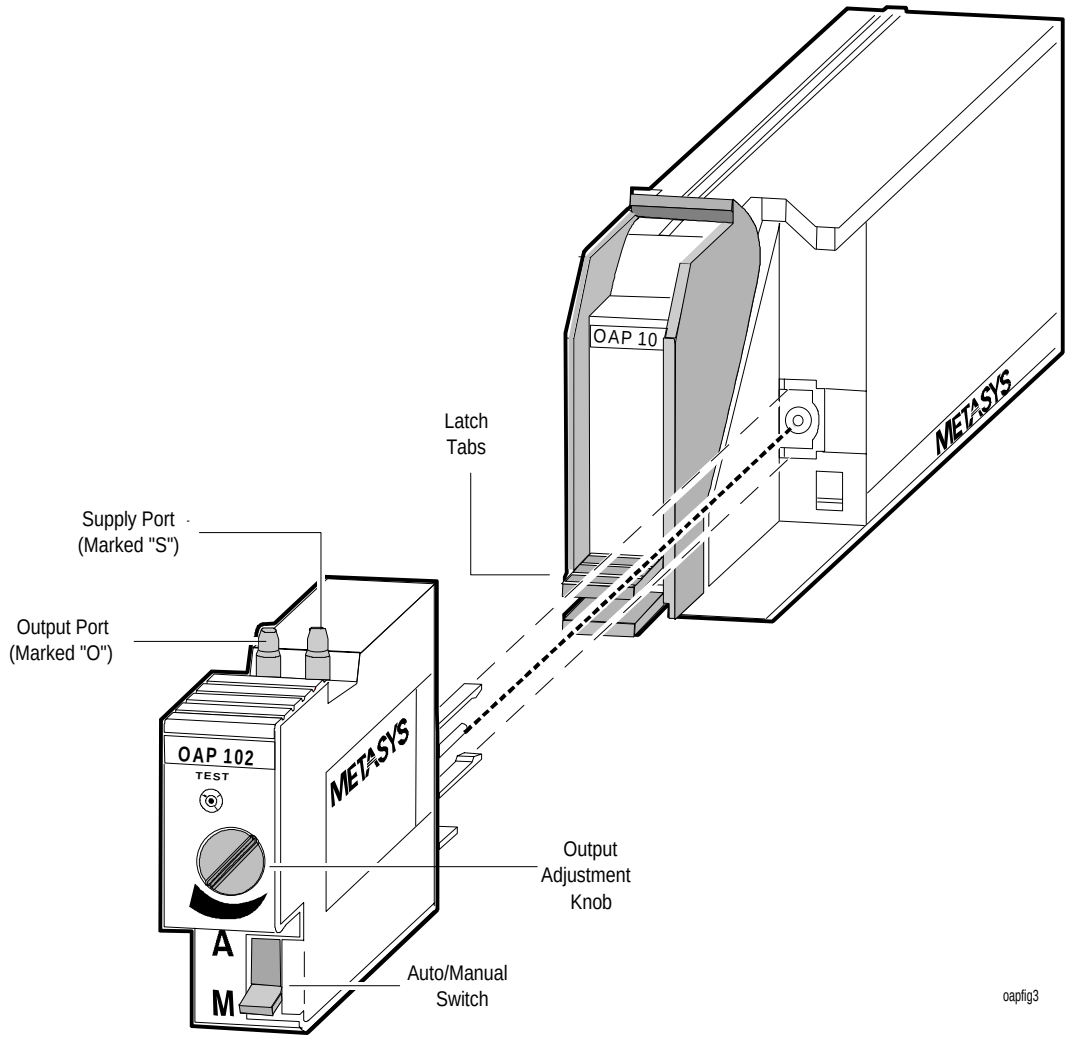

Figure 3: OAP Function Module Assembly

Commissioning

FM-OAP102

Commissioning

Assumptions

- Installation of FM-OAP102 is complete.
- Connections to field devices are complete.

Note: The OAP102 Manual Module can be commissioned and operated before the OAP101 or the OAP103 is installed.

Procedure

1. Move the Auto/Manual (A/M) Switch on the OAP102 to the "M" position for manual operation. Refer to Figure 5.
2. Adjust the manual control on the OAP102, and verify that the intended device responds.

Note: Turning the knob counterclockwise will decrease pressure, and turning the knob clockwise will increase pressure to the field device.

3. If the field device does not respond, refer to the *Troubleshooting* section of this bulletin.

FM-OAP101

Calibration

Assumptions

- Installation at the NCU/NEU panel is complete, including NCM, DCM, FM, etc.
- An Operator Workstation is available.
- The operating software for the network has been downloaded to the NCM controlling the panel.

Procedure

When calibrating the OAP101 zero and span adjustments, refer to the engineering drawings for specifications.

1. Move the Auto/Manual (A/M) Switch on the OAP102 to the "A" position. Refer to Figure 4.
2. At an Operator Workstation, proceed to the Focus window and override the object defined for this OAP to 0%.

3. Use a small, flat-blade screwdriver, and change the Zero adjustment (Z) to achieve the desired minimum position of the field device as indicated on the engineering drawings.
4. Next, at the Operator Workstation, override this object to 100%.
5. Use a small, flat-blade screwdriver to change the Span adjustment (S) on the OAP101 for the desired maximum as indicated on the engineering drawings.

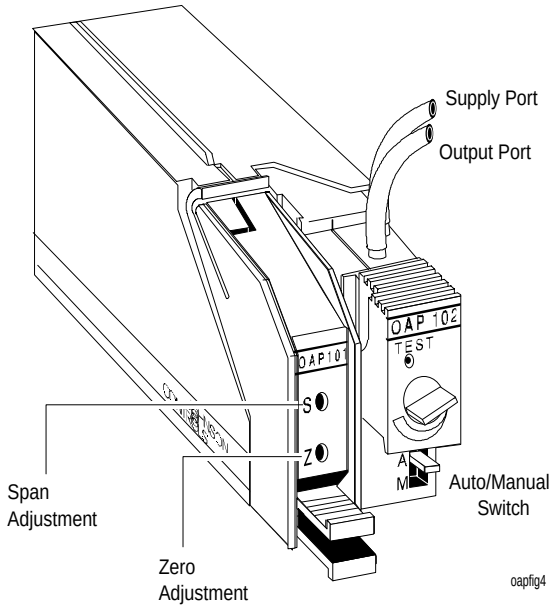

Figure 4: OAP101/102

Software Verification

Assumptions

- Calibration of the OAP101/102 is complete.
- An Operator Workstation is available.

Procedure

1. Select the System Summary that includes this OAP object.
2. Set the Auto/Manual switch on the OAP102 to Auto.
3. Using the Operator Workstation, set the software object to Auto to release the override.
4. Verify that the object's Value attribute (as seen in the summary) matches the actual value for the field device.

Assumptions

- The OAP103/102 Function Module assembly will be used with the AHU Controller.
- Installation of the OAP103/102 and FMK is complete.
- A laptop with HVAC PRO™ and a pressure gauge with a hypodermic test probe are available.
- The AHU Controller has been configured for use with the controlled device (by selecting "P" for pressure in the *Analog Output Configuration Table* of HVAC PRO). Refer to the *HVAC PRO User's Guide* as needed.

Procedure

Note: Calibrate the OAP103 at the midpoint of the field device range.

1. Move the Auto/Manual (A/M) switch on the OAP102 to the "M" position for manual operation. Refer to Figure 5.

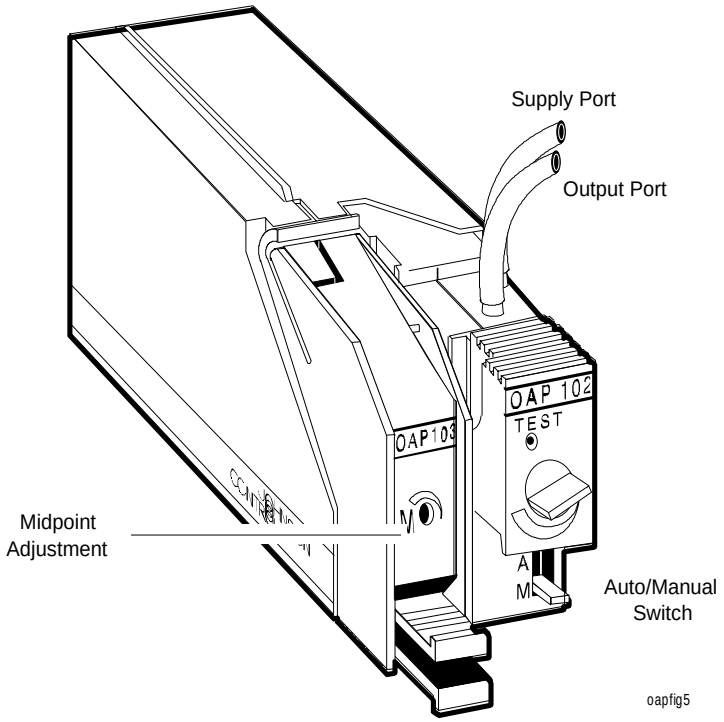

Figure 5: OAP103 Auto Module Installed with the OAP102 Manual Module

2. Connect a pressure gauge at the test port of the OAP102. This will be used to determine the actual spring range of the controlled device.

3. Using the controlled device under operating conditions (e.g., air or water flowing through device), measure:

   - the pressure required to drive the device fully open
   - the pressure required to drive the device fully closed

   If normal operating conditions (such as air or water flow) are available, the pressure needed to drive the field device fully open and fully closed should be used to determine actual spring range for calibration of the OAP103/102.

   If normal operating conditions are not available for the field device, use the nominal spring range specified for the controlled device, and estimate the spring range shift according to the information provided by the valve manufacturer.

Example: For a V–3754 (3/4 in. N.O. valve) with a 3 to 6 PSIG nominal spring range and a 20 PSIG pressure drop across the valve when closed, add 2 PSIG for spring range shift (as indicated by the valve manufacturer) resulting in a 3 to 8 PSIG actual spring range.

4. Return the Auto/Manual switch on the OAP102 to the "A" position for automatic operation.

5. Using the HVAC PRO configuration tool, enter the actual spring range values when prompted for the 0% and 100% commands in the AO H/W Table.

Example: For the valve specified above, with an actual spring range of 3 to 8 PSIG, you would enter a "3" at the 0% column, and an "8" at the 100% column.

6. Save, assemble, and download the entered values. Refer to the *HVAC PRO User's Guide* as needed.

7. Determine the midpoint of the actual spring range.

Example: If the actual spring range = 3 to 8 PSIG, the midpoint = 5.5 PSIG.

8. Using the HVAC PRO configuration tool, proceed to the Commission mode and override the Analog Output point (AO-n) of the controlled device to the 50% command.

9. With a pressure gage connected at the output port of the OAP103, use a small (1/8 in. or smaller), flat-blade screwdriver to adjust the recessed Midpoint (MID) adjustment on the OAP103 until the pressure at the controlled device is equal to the midpoint value determined in Step 7.

Note: Turn Counterclockwise (CCW) to increase output pressure and Clockwise (CW) to decrease pressure. Do not over turn adjustment screw. Less than one turn is needed in most cases.

Software Verification

Assumptions

- Installation of the OAP103 and OAP102 modules is complete.
- A laptop with HVAC PRO is available.
- Calibration of the OAP103 is complete.

Procedure

1. From HVAC PRO, command the Analog Output point (AO-n) of the controlled device to 100%, and check the field device for full open positioning.
2. Command the Analog Output point (AO-n) of the controlled device to 0% and check the field device for full closed positioning.

Note: The OAP103 is designed with a proportional gain of 1 PSIG output per mA of input. Some models may exhibit slightly higher or lower gain characterized by a controlled device (such as an actuator) that will not run full open or closed. In this case, the endpoint (0% and 100%) commands must be redefined. Use HVAC PRO to enter the modified 0% and 100% command values, as in Steps 5 and 6 in the *Calibration* Section.

Example: If the actual spring range = 3 to 8 PSIG but the controlled device will not run fully closed, enter “2” when prompted for the 0% command. If the device will not fully open, enter “9” when prompted for the 100% command.

Troubleshooting

If the OAP does not function properly and the calibration procedure cannot be successfully performed, use the applicable procedure below to check the unit.

FM-OAP101/102

Assumptions

- Installation of the OAP101 and OAP102 modules is complete.
- The DCM has been configured for use with the controlled device.

Procedure

Step 1: Check Input

a. Using a pressure gage, check the external pressure supply. If this pressure is less than 20 PSIG, troubleshoot the supply pressure system.

b. Check the OAP input filter located directly above the supply pressure port of the OAP102. If it is dirty or red, it must be replaced. Reorder Johnson Controls Part No. A-4000-137. (For additional information, refer to the *Ordering Information* section in the *FM-OAP101/102/103 Series Product Bulletin.*

Step 2: Check Output Pressure

a. Check supply and output pressure connections. Supply pressure should be connected to the port marked “S” and output pressure should be connected to the port marked “O.”

b. Check pressure at the OAP102 test port using a test gage with a hypodermic test probe. This pressure should be consistent with the value sent from the software.

Example: If the pressure at the test port is 12 PSIG at a value of 100%, and 4 PSIG at 0%, the pressure at the test port should be 8 PSIG when the value is 50%.

c. Check pressure at the field device. If the pressure is different from that found at the OAP102 test port, check the connections between the field device and the OAP102 output port.

Step 3: Check Software

a. At the Operator Workstation, go to the summary screen containing this object and check the summary describing this object.

- Notice the status listed in the left hand column (e.g., Is the object under software override?).
- Check the summary values for appropriate configuration. Refer to the *Operator Workstation User's Manual* to verify them.

b. Proceed to the Focus window. Check the object definition.

- Notice the Parameters, the Hardware DCM values, the Engineering Data, and the Report Type.

c. If any definition is questionable, refer to your *Operator Workstation User's Manual* to confirm this definition.

Step 4: Check Controller Response

Check the DCM error LED. If it is off, check if the N2 XMIT and RECV LEDs are flashing. If the DCM error LED is on or if either N2 LED is not flashing, refer to the DCM literature in the *Metasys Network Technical Manuals.*

Step 5: Check OAP101/102

a. While in Manual mode, turn the output adjustment knob and observe the change on a pressure gage inserted into the test port of the OAP102. The pressure change should be smooth and even. If the pressure change is erratic, the leak port is probably dirty or sticky, and the OAP102 should be replaced.

b. With the OAP101/102 assembly in Auto mode (A), and using the Operator Workstation (OWS):

1. Override the output to 100% and note the output pressure at the test port.
2. Override the output to 50% and note the pressure at the test port.
3. Override the output to 0% and note the pressure at the test port.
4. Override the output back to 50% and again note the pressure at the test port.

Observe whether or not the pressures at 0%, 50%, and 100% are stable and consistent. Unstable, inconsistent, or non-repeatable values may be caused by a dirty or sticky leak port, and the OAP101 should be replaced.

FM-OAP103/102

Assumptions

- Installation of the OAP102/103 is complete.
- Wiring connections have been made between the Function Module Kit (FMK) and the AHU Controller.
- The controller has been configured for use with the controlled device.

Procedure

Step 1: Check Output

a. Check supply and output pressure connections. Supply pressure should be connected to the port marked "S," and output pressure should be connected to the port marked "O."

b. Measure pressure at the OAP102 test port, using a test gauge with a hypodermic test probe.

Example: If the spring range is 4 to 9 PSIG, the pressure reading at the test port should be 9 PSIG when the analog output point (AO-n) of the controlled device is set to 100% and 4 PSIG when the analog output point (AO-n) is set to 0%.

c. Measure pressure at the field device. If the pressure is different from that found at the OAP102 test port, check the connections between the field device and the OAP102 output port.

Step 2: Check Input

a. Pressure input:

Using a pressure gage, check the external pressure supply. If this pressure is less than 20 PSIG, troubleshoot the supply pressure system.

Check the OAP input filter. If it is dirty or red, it must be replaced. Reorder Johnson Controls Part No. A-4000-137. (For more information, refer to the *Ordering Information* section in the *FM-OAP101/102/103 Series Product Bulletin.*

b. Current input:

1. Remove the OAP103/102 from the FMK.
2. On the FMK, use a multimeter set to the mA scale to check the current level through the wiring terminals for the corresponding OAP (B+ and B- for an OAP in the A/B slots or D+ and D- for an OAP in the C/D slots). Refer to Figure 2b as needed.

3. Compare the current reading on the multimeter to the actual spring range of the controlled device.

Example: If the spring range = 4 to 9 PSIG, the current reading should be 4 mA when the device is commanded to 0% and 9 mA when the device is commanded to 100%.

4. If the current reading does not match the spring range of the controlled device, the problem could be with the hardware configuration, the controller board, the termination board, or the connection to the FMK. Proceed to the *Installation Guide* of the *AHU Controller Engineering* documentation to isolate and correct the problem.

Step 3: Check OAP

a. Reinstall the OAP103 into the FMK.

b. While in Manual mode, turn the output adjustment knob and observe the change on a pressure gage inserted into the test port of the OAP102. The pressure change should be smooth and even. If the pressure change is erratic, the leak port is probably dirty or sticky, and the OAP102 should be replaced.

c. With the OAP103/102 assembly in Auto mode (A), and using the HVAC PRO Configuration Tool:

   1. Override the analog output point to 100% and note the output pressure at the test port.
   2. Override the analog output point to 50% and note the pressure at the test port.
   3. Override the analog output point to 0% and note the pressure at the test port.
   4. Override the analog output point back to 50% and again note the pressure at the test port.

   Observe whether or not the pressures at 0%, 50%, and 100% are stable and consistent. Unstable, inconsistent, or non-repeatable values may be caused by a dirty or sticky leak port, and the OAP103 should be replaced.

d. Measure the resistance through the OAP as follows:

   1. Remove the wires connecting the FMK to the AHU Controller.
   2. Measure the resistance across the wiring terminals for the corresponding OAP (B+ and B- or D+ and D-) using a multimeter set to the ohm scale. Refer to Figure 2b as necessary.

3. Check that the multimeter reads between 305 and 375 ohms. If it does not, the OAP103 is damaged and must be replaced.

Note: If the controlled device, the AHU, the FMK, and the OAP103 check out electrically but the output pressure remains incorrect, the OAP103 should be returned for a mechanical checkout as stated in the standard warranty provisions.

Repair Information

The FM-OAP101, 102, and 103 are not repairable. For replacements, contact the nearest authorized Johnson Controls distributor.

Notes

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Issue Date 0394
Printed in U.S.A.